Ch 12 Mol Comp of Gases

Ch 11 in New

Volumes taken by gases → reveals info about other props of gases

Dalton

Measuring + Comparing Vol of Reactive Gases

HMWK on Pg 3

Gay-Lussac

Saw

2L of H_2 + 1L O_2 → 2L H_2O

2 volumes + 1 volume → 2 volumes

Were Dalton but didn't know H_2 (atoms are indivisible)

Atoms Not created/Destroyed

Also Saw

H_2	+	Cl_2	→	HCl
1L		1L		2L
1 vol		1 vol		2 vol

Gay-Lussac's Law of combining vol - @ Const T + P the V of gas reactants can be expressed as ratios of small whole #'s

Avogadro stepped in said → equal Vol of gas @ same P + T have = # of molecules

↳ rejected Dalton by saying elements are diatomic

makes sense H_2 + Cl_2 → 2HCl

1 molecule 1 mole 2 molec.

1mol of a gas has 6×10^{23} atoms or molecules

According to Avogadro's Principle - = Vol have same # of molecules

There fore 1mol of any gas has same volume.

↳ This volume @ STP = 22.4 L

easier to measure mol of gas by Vol than mass

So $\frac{1\text{ mol}}{22.4L}$ is a conversion factor convert to mol ~~know~~ figure mass out.

Example → p 346, 347

Gas Density → Varies w/ T + P why B/c V changes

↳ Temp must Be stated

$$D_{STP} = \frac{\text{molar mass}}{\text{molar volume}} = \frac{g/mol}{22.4L/mol} = \frac{g}{\cancel{mol}} \times \frac{\cancel{mol}}{22.4L} = \frac{g}{22.4L}$$

Q 348

Molar Mass @ STP from V

$D_{STP} = \frac{\text{molarmass}}{\text{molar Vol}} \rightarrow \text{molarmass} = D_{STP} \times \text{mol Vol}$

$\frac{g}{L} \times \frac{22.4L}{mol}$

Do prob 348-349

IDEAL GAS Eqn $PV=nRT \rightarrow$

Boyle's Law $V \propto \frac{1}{P}$, Avogadro $V \propto n$

Charles' $V \propto T$

Gay Lus ~~P ∝ T~~

$V \propto \frac{1}{P} \times T \times n$

Related by a const ~~P~~ K

$PV = nRT$

$R = 0.0082 \frac{L \cdot atm}{mol\ K}$

all prop ↑

To ~~do~~ use this Eqn V in L

P in atm

T in K

$\frac{PV}{RT} = R$ const!

Ch 12 Q's p 350 q 6, 7

p 355 q 1, 3

p 360 q 1, ~~2~~, 3, 4 H p364 Q3 Hand Prob Q 10, 11, 12 p 367

18, 19 22

p 366 ~~prob~~ ~~Q~~ 1, 5, 7

p 367 Q 10, 11, 17, 20,

p 368 Q 31, ~~App Prob~~

pg 369 App Prob Q 22

p 364 35, 37

Q 40, 364

Using Ideal gas Law

$PV = nRT$ → can solve for any variable $PV n T$

↳ make sure $V = L$, $T = K$, $P = atm$ b/c $R = 0.082 \frac{L \cdot atm}{mol\,K}$

Examples pg 352-353

Finding molar mass by ideal gas Law

$mol = \frac{\text{mass}}{\text{molar mass}} = \frac{m}{M}$

$n = \frac{m}{M}$ → substitute → $PV = \frac{mRT}{M}$

$$M = \frac{mRT}{PV}$$

$Density = \frac{m}{V}$ → $M = \frac{DRT}{P}$ $\quad D = \frac{MP}{RT}$

Examples p 355

Stoichiometry of Gases

Thanks to Gay-Lussac + Avogadro

$2CO$	+ O_2 →	$2CO_2$
2 molecule	1 molec	2 molec
2 mol	1 mol	2 mol
2V	1V	2V

Ratio examples

$$\frac{2 \text{ vol } CO}{1 \text{ Vol } O_2} \text{ etc}$$

Vol-Vol Stoic

If 4 L of CO are used how much O_2 needed?

$$4 \text{ L } CO \times \frac{1 \text{ vol } O_2}{2 \text{ vol } CO_2} = 2 \text{ L } O_2$$

Not cut and dry

- mass → Vol
- Vol → mass

process

- gas Vol A → mol A → mol B → mass B
- mass A → mol A → mol B → Vol B

@STP $\frac{22.4 \text{ L}}{1 \text{ mol}}$ or Use Ideal @ Non Standard $PV = \underline{n}RT$

Sample problem 359

12.4 Diffusion & Effusion

Constant motion of gas molecules causes them to spread out.

Diffusion - mixing of 2 gases due to their spontaneous Random motion

Show overhead

Effusion - Container w/ a small opening gases will encounter it and pass through.

But the rate of both depends on... T, M

Vel varies inversely w/ mass M ↑, V ↓

For Temp (measure of Avg KE) @ a given T

$KE = \frac{1}{2}mv^2$ ← Physics (we are talking about particles in motion)

Diffusion / Effusion is better understood by looking @ 2 gases @ same T + P.

where gas = $KE_A = \frac{1}{2} M_A v_A^2$ M = molar mass

Temps!

$KE_B = \frac{1}{2} M_B v_B^2$

So $\frac{1}{2} M_A v_A^2 = \frac{1}{2} M_B v_B^2$

$$M_A v_A^2 = M_B v_B^2$$

Better to compare them as velocities as a ratio

So $\frac{V_A^2}{V_B^2} = \frac{M_B}{M_A}$ reduce → $\frac{V_A}{V_B} = \frac{\sqrt{M_B}}{\sqrt{M_A}} = \frac{\text{rate of effusion A}}{\text{rate of effu B}}$

Scottish Chemist Thomas Graham

Graham's Law of effusion/diff: molecular velocities of gase are inversely proportional to the square roots of their molar masses at the same T

→ can vary it too!

$$\frac{\text{rate of effusion A}}{\text{rate of effusion B}} = \frac{\sqrt{M_B}}{\sqrt{M_A}} = \frac{\sqrt{D_B}}{\sqrt{D_A}}$$

or $\frac{\text{effusion time A}}{\text{effusion time B}} = \frac{\sqrt{M_B}}{\sqrt{M_A}} = \frac{\text{dist traveled A}}{\text{dist traveled B}} = \frac{\text{molecular vel A}}{\text{molec vel B}}$

Do Demo of NH_3 + HCl in tube

Applications → in Technology can use to separate light isotopes from heavy isotopes

also Calculation of unknown molar mass.

Compare Rate effusion of known to unknown + calc Molar mass!

Sample Prob 12.14

$M_A = H_2 = 2.0 g/mol$

$M_B = O_2 = 32.0 g/mol$

$$\frac{rate A}{rate B} = \frac{\sqrt{32.0 g/mol}}{\sqrt{2.0 g/mol}} = \frac{5.6}{1.4} = \frac{4}{1}$$

H_2 diffuse 4X as fast!

Practice Prob

$$\frac{rate_A\ H_2}{rate_B\ X} = \frac{8.94}{1} = \frac{\sqrt{X g/mol}}{\sqrt{2 g/mol}} = 79.9 = \frac{X g/mol}{2 g/mol} = 160. g/mol$$